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Relational Study of Information Technology and Production Management: - The Case of Closer Economic Partnership Arrangement (CEPA) between Mainland China and Hong Kong

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Abstract
In the last few decades, many large corporations have been moving part of the supply chains, especially manufacturing, offshore to take advantage of the low cost resources and labor. For example, the southern part of China, such as Pearl River Delta (PRD), has been attracting the enterprises from all over the word in the last two decades and has become the world manufacturing hub. The types of the manufacturing extend the spectrum from light industry (e.g. toy and garment) originally to high-tech (e.g. semi-conductor wafer) recently and such transition triggers the changes of the technology requirements. In addition, joining WTO has opened up the gate to China and sped up the process of technology advancement as well. The paper investigates the relationships between technology adoption and production management by examining production technology, information systems, and information qualities in a study based on the review of the Closer Economic Partnership Arrangement (CEPA) between Hong Kong and China. The paper concludes the recommendations for the capability building to bridge the gap for information systems and operations management in China.

Keywords: Information Systems, Information Quality, Production Management, CEPA

Introduction

The world, especially East Asian, economies have embarked on regional economic cooperation in a lot of areas, following the financial crisis in 1997-1998. The regional economies realize the importance of closer economic cooperation among themselves which were increasingly interdependent. It is essential to undertake various initiatives for the institutionalization of such interdependence. Cooperation in a lot of domains, such as economic, financial, and IT, has been explored. For instances, Japan and Singapore concluded an economic partnership agreement (EPA), and many official discussions and negotiations for bilateral and sub-regional free trade agreements (FTAs)—such as Japan-Korea EPA, China-ASEAN FTA and Japan-ASEAN EPA—are currently underway. In the financial area, the ASEAN+3 members—comprising ASEAN, China, Japan and Korea—began to undertake the Chiang Mai Initiative, economic surveillance and policy dialogue, and the Asian bond market development initiative. In information systems management area, China and ASEAN signed a Framework Agreement on Comprehensive Economic Cooperation in November 2002. The parties agree to cooperate in goods and services (Part 2), agriculture, information and communications technology, etc. In Chinese Regional Agreements with Australia and New Zealand, they will cooperation in information and communication technology as well as e-commerce. Additional aspects of the projects focus on the development of human resources and regional communication (www.move-in.org).

Mainland China and Hong Kong set up even closer economics ties during the third anniversary of the Closer Economic Partnership Arrangement (CEPA) this July. Three stages of CEPA have been signed since June 2003. Moreover, the two sides are expected to sign further agreements to boost economic cooperation, particularly in service trade (China Daily, Jun 29, 2006). CEPA constitutes derogation from the principle of the most-favored-nation (MFN) treatment in the WTO. The benefits offered through WTO commitments are the bottom line for both sides and more favorable treatment will not extend to other WTO members. Since July 1, zero tariff products with certificates of origin have been expanded from 1,370 items to 1407 items (SinoCast China Business Daily News, Jul 3, 2006). The latest deal contains 15 liberalization measures for 10 sectors – legal, construction, information technology, convention and exhibitions, audiovisual, distribution, tourism, air transport and road transport, and individually owned stores (South China Morning Post, Jun 30, 2006). The Hong Kong government has exported goods worth $4.76 billion for tariff-free to the mainland under CEPA since January 2004. CEPA had created 30, 000 jobs in the past two years (South China Morning Post Jun 21, 2006) and there are 10 mutual recognition of each others' qualifications arrangements under CEPA (South China Morning Post Jun 30, 2006). So far the mainland has opened up 27 service sectors, such as logistic, distribution, tourism and banking, to investors from Hong Kong (China Daily, Jun 29, 2006). The CEPA covers three broad areas, i.e. trade in good, trade in services, and trade and investment facilitation. The products covered by CEPA were classified according to 273 mainland tariff code or 405 Hong Kong product codes. The government has certified 971 services companies for operation on the mainland, 72 per cent of them in the logistics and distribution sectors (South China Morning Post Jun 21, 2006). Many of made-in-Hong Kong products are electronic or IT-related products. Some value-added telecommunications service will enjoy a three-month time advantage under CEPA though WTO commitments also require China to open this market. E-commerce is listed in the trade and investment facilitation and both Hong Kong and Mainland China have acknowledged its importance.

In this context, we are motivated by the increasing importance of relational study between manufacturing operations and multiple information systems which has not much been done. The paper focuses on the examination of the current status and expectations of IS and production management which IS supported. The correlations between information system and manufacturing operations are analyzed from two perspectives, i.e. system level and information quality level. We investigate several interesting implications from the case of the CEPA. In section 2, we will look into the related literature. Research design and methodology will be presented in section 3. Section 4 will demonstrate major findings. Implications will be illustrated in section 5. In section 6 we will draw conclusions, give suggestions, represent contributions, review limitations of the study, and discuss future directions.

Literature Review

The WTO, opening up the gate to China, has further sped up the process of evolution of technology advancement. Regional cooperation in information systems can help optimize the resource allocation in a modern economy, enhance the supply chain, implement and integrate regional information and data networks. We will illustrate the literature and benefits brought by CEPA. With a focus on the study of information system, which is defined in CEPA as trade and investment facilitation, we identify literatures on information system and the corresponding manufacturing operations. Information quality is also included because of its importance in data exchanging and sharing in modern information systems.

First, the CEPA (Closer Economic Partnership Arrangement) has brought plenty of benefits and opportunities for mainland and Hong Kong. In June 2004, the concept of regional economic integration was inaugurated in the Pan-Pearl River Delta Regional Cooperation and Development Forum (Chiu 2006). By improving the access for Hong Kong services companies to the mainland market, CEPA enable mainland enterprises join hand with Hong Kong companies to provide efficient and sophisticated production supporting services. Hence it further improves the global competitiveness of China's manufacturing industries. Information systems, such as e-commerce, are listed in CEPA as trade and investment facilitation. It is vital in this sense that information systems management can contribute to the manufacturing operations in transition of the focus from simple low-end product to high added-value product. Literature developed long-lasting adaptive infrastructures, which can handle the continuously increasing service demands and threats (Ramamoorthy et al. 2005). Past study found that a superior IT infrastructure significantly reduces the cost of operations for high-growth firms in subsequent periods (Mitra 2005). Literature presents a methodology that combines ISO standards and UML (Unified Modeling Language) standards to react to changes in the business model and their technology platform (Losavio et al. 2004).

Second, in literature some researchers addressed the use of a single IT application (Harold, 1997; Holmstrom, 1998), and some investigated multiple IT application throughout the supply chain (Craighead and Laforge, 2002; Subramani, 2004). Some researchers examine the relationship between the relative size of IT investments by firms and their productive efficiency in the production process (Lin and Shao, 2000). They find consistent empirical evidence that the relative level of IT investments has a positive effect on the firm's productive efficiency. The result suggests that firms investing comparatively more in IT are likely to be more efficient in their production processes than those investing less. Their study confirms the positive effect of IT on the firm's efficiency in the production process. Our study is strongly motivated by the advance of contemporary technology and a variety of productions and daily work it enables.

Moreover, modern information systems are often the result of multiple systems interacting with each other, exchanging data through Internet or other networks. When data are exchanged and shared, there is less tolerance for poor information quality. As a result, information quality also plays an important role in information system management. The definition of information quality varies in different research for different purpose. Lee et al. (2002) includes security and operations as accessibility information quality, while Yang et al. (2005) includes content related criteria in information quality and put ease of use and security into system quality. In our study, we take account of all these important features in literature, e.g. accuracy, timeliness, security, etc. Information is the most valuable wealth and most important political and economic resource of a country. Information system, for example, Internet, helps eliminate borders, provides access to knowledge and information and brings opportunities to find new partners in the whole world. Internet should be used as a tool for promoting constructive dialogue and productive cooperation. Information system should not only act as a carrier in the information world, but also, more importantly, promote better integration among regions with diversified cultures.

Motivated by the increasing importance of information systems which interact with manufacturing operations and with each other, this paper investigates the current status of different information technology, the different production technology it facilitates, and the information quality it incorporates. Little research has been done on multiple information systems and their correlation with corresponding manufacturing operations.

Research Methodology

This research integrates literature synthesis and survey to investigate the current status of information systems management in Hong Kong manufacturing and engineering industries. Based on literature, the management of information systems along the valued chain has a large effect on business. Besides the functionality that information system provided, quality information also plays an important role in the information systems management. We aim to investigate the correlation between information systems and manufacturing production at both system level and information quality level.

Self-administrated questionnaires (in both English and Chinese) were used in this survey. The questionnaires were filled and sent back to us by mail or by fax. To improve the response rate, returned envelop was provided as well. To make the survey more representing, we have employed a professional Statistical Consulting Unit as the agent to coordinate the distribution of questionnaire, receipt of reply, data entry and basic analysis of the data. The sampling frame was provided by Hong Kong Productivity Council. 1,705 letters were sent out by mail and 2,140 were sent by fax. The survey period was between 10th August and 26th August 2005. Follow-up calls were made to companies which did not respond in the middle of the survey period. After deducting 666 invalid addresses, there are 71 respondents. The target respondents were managers of companies in the manufacturing and engineering industry.

The questionnaire includes several parts. First, the company profile part includes the business nature, e.g. textiles and clothing, transportation and logistics services, etc. The respondent's perspective about CEPA part consists of the CEPA application status, and the reason why it applied or not applied for CEPA, and the application channel. The main part includes the expectation and satisfaction level of performance of information systems, information quality, and manufacturing operation systems. Information systems involved in this study include both infrastructures that are underlying foundations and advance technology, such as Radio Frequency Identification (RFID). Table 1 illustrates the detail of the items in the three constructs and their abbreviation names, which we use for conciseness. A 5-point Likert scale was used to indicate the expectation and satisfaction level at the same time.

Table 1: Items in Manufacturing Operations(OM), Information System (IS), and Information Quality IQ)

OM	IS	IQ
A1. Research and Development (R&D)	B1. Databases management system (DBMS)	C1. Accuracy
A2. Product Design (PD)	B2. Telecommunication & Network (Network)	C2. Timeliness
A3. Procurement and Purchasing (PP)	B3. Electronic Data Interchange (EDI)	C3. Accessibility
A4. Production Planning & Scheduling (PPS)	B4. Internet/Intranet/Extranet (Internet)	C4. Ease of Operations
A5. Cost Analysis (CA)	B5. Wireless Technology (Wireless)	C5. Security
A6. Quality-related Activities (QA)	B6. Barcode and Scanning (Barcode)	C6. Relevancy
A7. Productivity Improvements (PI)	B7. Radio Frequency Identification (RFID)	C7. Completeness
A8. Customers Relationship Management (CRM)	B8. Simulation Systems (Simulation)	C8. Concise representation
A9. Product Life Cycle Management (PLCM)	B9. Decision Support Systems (DSS)	C9. Consistent representation
A10. Enterprise Resources Planning (ERP)	B10. Enterprise Resources Planning (ERP)	C10. Easy of understanding
A11. Logistics and Supply Chain Management (SCM)	B11. Web services (Web)	
A12. Inventory Management (IM)		

Over 80% of the respondents are in managerial and administrative positions in their companies and half of the respondents have over 15 years work experience. Over half of the respondents are in the industry of textile and clothing. 87.3% of the respondents are locally located and over two-thirds of the respondents' production centers are in Guangdong. 37.3% of the respondents operated in the mode of OEM (Original Equipment Manufacturer) and ODM (Original Design Manufacture), another 20.9% of them focused on OBM (Original Brand Manufacture). It is unexpected to find that over 90% of the respondents have not applied for CEPA. The main reasons are due to the lack of knowledge about CEPA, as the unfavorable business environment as well as wrong type of customer and market. Another obvious reason is that they are unable to move their plant to Hong Kong. For those who have applied for CEPA, the majority (71.4%) thought that "enjoy the reduced tariff" is the most important factor while 57.1% and 28.6% of respondents thought that "enter Mainland's market" and "reduce the cost of production" are the second and the third important factor respectively.

Case Findings

In this section, we will illustrate the expectation of and satisfaction with respondent's information systems, information quality, and their corresponding manufacturing operations. Then we will investigate the correlations between IS and OM at multiple levels.

Preliminary Result of IS, IQ, and OM

Modern information systems are often the result of multiple systems interacting with each other and exchanging data through Internet or other special purpose networks. When data are exchanged and shared, there is less tolerance for poor information quality. In this section, we will investigate the performance of information systems as well as information quality and manufacturing operations in the respondents' companies.

Information Systems

Concerning the various information systems, in Table 2 it is found that Network and DBMS are the top two important issues to the responding companies, which score 4.20 and 4.09 among the 11 attributes. The Simulation, which scores 2.50, is thought to be the least important information systems element in the responding companies. In this study we classified fundamental components (e.g. DBMS, Network, EDI, Wireless Technology, Barcode, Web service, and Internet) that enable manufacturing into IS infrastructure and other advance technology (RFID, DSS, ERP, and Simulation) into advanced IS.

Regarding the various information systems, it is shown that Network, Internet and Web are the top three most satisfying areas in the responding companies, which score 3.52, 3.40 and 3.25 among the 11 attributes. On the other hand, "Simulation System" is the least satisfying element in the related areas, which scores 2.09 only.

Information Quality

Concerning the information quality, it is reported that "Accuracy", "Timeliness" and "The Ease of Understanding" are the top three important issues to the responding companies, which score 4.43, 4.13 and 4.09 among the 11 attributes. It is shown that "Accuracy" and "Ease of Understanding" are the top two most satisfying areas in the responding companies, which score 3.61 and 3.33 among the 10 attributes. On the other hand, "Relevancy" is the least satisfying element in the related areas, which score 3.00 only.

Table 2: Descriptive Statistics - Level of Importance/Level of Satisfaction of IS to Responding Companies

ID	Information Systems	IS Classification	Mean of Importance	SD	Rank	Mean of Satisfaction	SD	Rank
B2	Network	Infrastructure	4.20	0.955	1	3.52	0.980	1
B1	DBMS	Infrastructure	4.09	1.011	2	3.16	1.065	4
B4	Internet	Infrastructure	3.86	1.021	3	3.40	1.036	2
B11	Web	Infrastructure	3.76	1.103	4	3.25	1.102	3
B9	DSS	Advanced IS	3.69	1.067	5	3.04	1.176	5
B10	ERP	Advanced IS	3.69	1.148	6	3.00	1.166	6
B3	EDI	Infrastructure	3.34	1.06	7	2.63	1.064	7
B6	Barcode	Infrastructure	3.05	1.208	8	2.48	1.089	9
B5	Wireless	Infrastructure	2.79	1.063	9	2.48	1.248	8
B7	RFID	Advanced IS	2.71	1.242	10	2.17	1.200	10
B8	Simulation	Advanced IS	2.50	1.206	11	2.09	1.067	11

Remark: Number of respondents of level of importance of IS ranges from 46 to 65
Number of respondents of level of satisfaction of IS ranges from 35 to 52

Table 3: Descriptive Statistics- Level of Importance/Level of Satisfaction of IQ to Responding Companies

ID	Information Quality	Mean of Importance	SD	Rank	Mean of Satisfaction	SD	Rank
C1	Accuracy	4.43	0.80	1	3.61	0.96	1
C2	Timeliness	4.13	0.87	2	3.30	0.95	3
C10	Ease of Understanding	4.09	0.85	3	3.33	0.89	2
C4	Ease of Operations	4.05	0.92	4	3.30	0.93	4
C5	Security	4.05	0.94	5	3.222	0.94	6
C8	Concise Representation	3.92	1.00	6	3.16	1.00	7
C3	Accessibility	3.89	0.90	7	3.25	1.04	5
C9	Consistent Representation	3.83	0.91	8	3.09	0.99	8
C7	Completeness	3.78	0.98	9	3.04	1.01	9
C6	Relevancy	3.75	0.92	10	3.00	1.01	10

Remark: Number of respondents of level of importance of IS ranges from 63 to 67
Number of respondents of level of satisfaction of IS ranges from 55 to 57

Manufacturing Operations

Concerning the various manufacturing operations, it is deemed that PI, PPS, and R&D are the top three important issues to the responding companies, which score 4.30, 4.18 and 4.08 among the 12 attributes.

Table 4: Descriptive Statistics- Level of Importance/Level of Satisfaction of Manufacturing Operations to Responding Companies

ID	Manufacturing Operations	Classification	Mean of Importance	SD	Rank	Mean of Satisfaction	SD	Rank
A7	PI	Internal	4.3	0.92	1	3.333	1.136	4
A4	PPS	Internal	4.18	1.079	2	3.400	0.994	1
A1	R&D	Internal	4.08	1.215	3	3.348	0.939	2
A5	CA	Internal	4.03	0.94	4	3.178	0.953	8
A2	PD	Internal	4.02	1.306	5	3.341	1.037	3
A3	PP	External	3.92	0.971	6	3.262	0.935	5
A6	QA	Internal	3.86	1.075	7	3.191	1.035	7
A8	CRM	External	3.73	1.079	8	3.211	1.029	6
A12	IM	Internal	3.7	1.109	9	3.098	1.114	9
A11	SCM	Integration	3.67	1.041	10	3.075	0.971	10
A10	ERP	Internal	3.64	1.003	11	2.875	1.025	12
A9	PLCM	Integration	3.49	1.052	12	3.000	0.992	11

Remark: Number of respondents of level of importance of IS ranges from 55 to 64
Number of respondents of level of satisfaction of IS ranges from 40 to 48

For the various manufacturing operations mentioned, it is found that PPS, R&D, and PD are the top three satisfying areas to the responding companies, which score 3.40, 3.35 and 3.34. On the other hand, the ERP, which scores 2.88, is the least satisfying area of manufacturing operations in responding companies.

In this study, manufacturing operations are classified as internal operation, external coordination, and integration. Internal operations are the operation within the company, including “Research and Development”, “Product Design” “Production Planning & Scheduling”, “Cost Analysis”, “Quality-related Activities”, “Productivity Improvements”, “Inventory Management” and “Enterprise Resources Planning”. External coordination is the process that involves one external party, including “Procurement and Purchasing” and “Customers Relationship Management”. “Product Life Cycle Management” and “Logistics and Supply Chain Management” are integrated operations, which are operations that may involve more parties.

Expectation and Satisfaction

After the statistical analysis, significant differences are found between level of expectation and level of satisfaction in all IS, IQ, and OM features. It is obvious that there is a gap between the two and all the performances need to be improved. However, there are some consistencies in the expectation and satisfaction. Network, Internet, Web, DBMS, and DSS, are the top five issues in both expectation and satisfaction in information systems. Though ERP, EDI, and Barcode are deemed of importance and score above 3, they are not quite satisfying in performance and score much lower. Wireless, RFID, and Simulation score the lowest in both expectation and satisfaction.

Gaps were found between expectation and satisfaction in information quality and manufacturing operations, too. However, significant correlation is shown in the analysis between the expectation and satisfaction. We will explain the phenomena in Section 5.

Correlations Analysis of Information Systems and Manufacturing Operations

Information systems change the way manufacturing operations have been done. Both functionality at system level and the data feature at information quality level affect the operations. It is found that information systems correlate significantly with information quality as well as manufacturing operations. In this section, we will investigate the correlations between IS and OM at multiple levels.

Correlation at System Level

Manufacturing operations are classified as internal operation and external coordination. RFID and Simulation are not paid much attention at this stage, because they get the lowest score in both expectation and satisfaction. It is possible that respondents’ companies did not apply or were not interested in these two technologies. In Table 5 we analyze how significant the correlation between manufacturing systems and information systems in terms of expectation and satisfaction, respectively. The correlation between all manufacturing and IS are significant (at level 0.01). Some of the findings are illustrated as following. First, it is expected that IS infrastructure is highly correlated with internal operation. Second, it is expected that advanced IS is highly correlated with external coordination and integration. Third, level of satisfaction is higher than expectation except in the correlation of advanced IS between internal operation and integration.

Table 5: Correlation of IS (Bx) with each OM (Ax) feature at system level

IS\OM	Internal		External		Integration	
	E	S	E	S	E	S
IS Infrastructure	.614(**)	.667(**)	.347(**)	.656(**)	.382(**)	.711(**)
Advanced IS	.551(**)	.525(**)	.448(**)	.622(**)	.514(**)	.488(**)

E-Expectation; S-Satisfaction

Correlation at Information Quality Level

In this section, the correlation between IS and IQ, and that between IQ and OM will be investigated further. Then we will study the correlation between IS and OM on the IQ level.

In this study Information Systems are divided into IS infrastructure and advanced IS in this work. However, the infrastructure varies a lot in different industries and keeps evolving as new technology emerges (Ramamoorthy and Seker, 2005). We analyze how significant the correlations in terms of expectation and satisfaction, respectively. The correlations between information systems and information quality are all significant. This indicates that all the information quality criteria are important to IS, both in terms of IS infrastructure and advanced IS. Table 6 illustrates the correlations of different IQ features with each information system. We can see that different information system tends to emphasis on different information qualities.

Table 6: Correlation of IQ (Cx) feature with IS

IS \ IQ	*C1*		*C2*		*C3*		*C4*		*C5*	
	E	S	E	S	E	S	E	S	E	S
Infrastructure	.581	.541	.576	.394	.563	.580	.565	.554	.629	.577
Advanced IS	.319	.561	.388	.545	.471	.577	.363	.590	.430	.505
IS \ IQ	***C6***		***C7***		***C8***		***C9***		***C10***	
	E	S	E	S	E	S	E	S	E	S
Infrastructure	.495	.439	.568	.461	.553	.476	.622	.439	.592	.590
Advanced IS	.397	.343	.490	.490	.549	.523	.546	.585	.409	.556

We believe that different information quality can facilitate or support different manufacturing operations. Table 7 demonstrates the correlation of different information quality with each operation category.

Table 7: Correlation of IQ (Cx) feature with each OM

IQ\OM	Internal		External		Integration	
	E	S	E	S	E	S
C1	.497(**)	.350(*)	.275(*)	.489(**)	.236	.418(**)
C2	.508(**)	.335(*)	.326(*)	.279	.334(*)	.297
C3	.409(**)	.463(**)	.357(**)	.488(**)	.409(**)	.502(**)
C4	.408(**)	.424(**)	.469(**)	.464(**)	.363(**)	.466(**)
C5	.535(**)	.358(*)	.322(*)	.426(**)	.351(**)	.513(**)
C6	.407(**)	.366(*)	.258	.429(**)	.302(*)	.490(**)
C7	.464(**)	.348(*)	.292(*)	.389(*)	.512(**)	.443(**)
C8	.530(**)	.434(**)	.395(**)	.380(*)	.450(**)	.507(**)
C9	.494(**)	.368(*)	.358(**)	.344(*)	.523(**)	.444(**)
C10	.419(**)	.410(**)	.390(**)	.363(*)	.271(*)	.493(**)

E-Expectation; S-Satisfaction

In Table 8, we get the correlation between information systems and manufacturing operation through their correlation with information quality. We found that quite a few consistent exist in both system level and information quality level. Some information systems are expected to be important for almost all manufacturing operations, while some are expected not to be of great importance. Some information systems are quite important at IS level but not at IQ level and vise versa. Findings are summarized as following. First, it is expected that IS infrastructure is much more highly correlated with all operations than advanced IS. Second, level of satisfaction is higher than that of expectation except the correlation of advanced IS with internal operation.

Table 8: Correlation of IS with each OM at IQ level (by multiplying ISIQ and IQOM correlations)

IS\OM	Internal		External		Integration	
	E	S	E	S	E	S
IS Infrastructure	2.692	1.962	1.854	1.964	2.023	2.218
Advanced IS	2.047	2.043	1.406	1.984	1.619	2.242

E-Expectation; S-Satisfaction

Comparison of Correlations at System and IQ level

When we compare the correlations of IS and OM at two levels, we find that quite a few consistencies exist. In the following, we list some of the consistencies as following. First, it is expected that IS infrastructure is much more highly correlated with internal operation than advanced IS. Second, in terms of satisfaction, external coordination correlated with IS higher than that in terms of expectation. Third, in terms of satisfaction, internal operation correlated with advanced IS lower than that in terms of expectation. Fourth, in terms of satisfaction, integration operation correlated with IS infrastructure higher than that in terms of expectation. Some inconsistencies are highlighted in Table 9, Table 10 and Table 11.

Table 9: Expectation correlations of IS and OM

IS\OM	Internal		External		Integration	
	System Level	IQ Level	System Level	IQ Level	System Level	IQ Level
IS Infrastructure	High	High	Low	High	Low	High
Advanced IS	Low	Low	High	Low	High	Low

Table 10: Satisfaction correlations of IS and OM

IS\OM	Internal		External		Integration	
	System Level	IQ Level	System Level	IQ Level	System Level	IQ Level
IS Infrastructure	High	Low	High	Low	High	Low
Advanced IS	Low	High	Low	High	Low	High

Table 11: Satisfaction better or worse than expectation of IS and OM

IS\OM	Internal		External		Integration	
	System Level	IQ Level	System Level	IQ Level	System Level	IQ Level
IS Infrastructure	Better	Worse	Better	Better	Better	Better
Advanced IS	Worse	Worse	Better	Better	Worse	Better

Discussions

In this section, we will explain the detail and discuss the implication of the results in section 4. First, evaluation of information systems, information quality, and manufacturing operations will be discussed, respectively. Then gap analysis and correlations analysis will be covered.

Implications of IS, IQ, and Manufacturing Operations

Information Systems

In information systems, Network and DBMS are the most important issues expected by respondents. In terms of level of satisfaction, Network and internet rank highest. However, respondents are not quite satisfied with them and they score much lower in satisfaction. DBMS fell from the second in expectation to the fourth in satisfaction. This result may indicate that the development of DBMS is far from fulfillment in infrastructure design in the respondents' companies. Wireless, RFID, and Simulation rank low due to probably two reasons. First, RFID is quite new and may not apply to many companies, especially the small one. Second, the application of some technologies are quite domain specific and the respondents' companies may not need these technologies according to their manufacturing nature.

Information Quality

Quality has been defined as fitness for use, or the extent to which a product successfully serves the purposes (Kahn, et al. 2002). In this study, accuracy is deemed as the most essential factor in information quality both in terms of expectation and satisfaction. Though all the quality rankings are above 3 out of 5, there are still significant differences between expectation and satisfaction for all criteria in information quality. This discrepancy implies that the respondents are quite satisfied with the information quality provided by the information system. However, there is still room for improvement in the quality of information, in terms of accuracy, timeless, security, etc. There are significant correlations between different information quality criteria (at significance level 0.01). An EFA analysis showed that all the factors loaded high in one component and strongly supported that argument that they are measuring the same construct information quality.

Manufacturing Operations

It is expected that "Productivity Improvement" and "Production Planning and Scheduling" are most vital in manufacturing operations. Though "Productivity Improvement" dropped to the fourth in terms of satisfaction, it is good to see that "Production Planning and Scheduling" and "Research and Development" get more attentions and have achieved better satisfaction level. There are significant differences between expectation and satisfaction for all criteria in most manufacturing operations. The inconsistency implies a great improvement in manufacturing operations. It seems that companies need to improve their operations in all the stages of supply chain, including procurement and purchasing, logistics, etc. There is correlation between different manufacturing operations. Accordingly, different operations and activities will affect each other in the manufacturing process.

Expectation and Satisfaction

For discussion of significant level of expectation and satisfaction, a paired t-test is used to compare these two groups. The Person correlation is positive and the p value is small in the paired t-test, which indicates the pairing was effective. The correlation between expectation and satisfaction in IS, IQ, and OM also indicated the validity of the paired sample test. In this section, we will discuss the implications of the gap and correlations between level of importance and satisfaction. For all the IS, IQ, and OM, the level of satisfactory is much lower than that of expectation. However, they are highly correlated. In a survey of information system "user expectation" was ranked second in a list of 33 items affecting user satisfaction (Conrath and Mignen, 1990). Literature finds that hardware and instruction component, support, and human factors will affect satisfaction (Ryker et al. 1997; Bergersen, 2004). Vendors may raise user expectations by emphasizing good features to sell their products. However, when the results user gets may not as satisfied as expectation. In this sense, improvement is eagerly demanded in most of the features of IS, IQ, and OM. Furthermore, Szajna and Scamell (1993) also emphasized the importance of users having realistic expectations. Studies indicate that expectations are determined by word-of-mouth communications, personal needs, past experience, and communication by the service provider (Zeithaml, et al. 1993). Three categories of sources were found from past study (Ryker, et al. 1997), including sources internal to the organization, sources external to the organization, and past experience.

Implications of Correlations between IS and OM

We study the correlation at two different levels. At system level, different operation and business functionality may require different information system functions. At information quality level, different operations may demand different information quality features supported by various information systems (Muylle, et al. 2004; Szajna 1994; Subramanian 1998).

Correlation at System Level

According to the analysis in last section, the expectation of information system to assist operations are mostly confirmed in the performance. At systems level, IS infrastructure supports internal operation best and performs out of expectation. IS infrastructure has been put quite a lot emphasis on and performs better than expectation in all manufacturing operations. Advanced IS supports external coordination well and also get pretty high satisfaction comparing with expectation. It also supports internal operations and integration, but the satisfaction is a little bit lower.

We can conclude that IS infrastructure plays an important role in manufacturing operations. Internal operations such as production planning and cost analysis need more development in IS infrastructure, for example, DBMS. IS infrastructure is evolving as time goes by and advanced technology improve the fundamental operations, e.g. R&D and product design. Therefore, we recommended that companies should focus on the development and maintenances on the IS infrastructures and keep an eye on the new technology that may help their business process.

Correlation at Information Quality Level

Information quality plays an important role in the performance of information system. In this section, correlations are investigated between IS and OM at information quality level. In literature four dimensions of information quality have been identified, i.e. intrinsic, contextual, representation, and accessibility information quality (Lee et al. 2002; Katerattanakul and Siau, 1999). However, we focus the detail IQ feature of different IS and do not apply the classification in the study. The significant correlations between information systems and information quality are significant indicates that all the information quality criteria involved in this study are related to IS, both in terms of IS infrastructure and advanced IS. For different IS infrastructure we may need different aspect of information quality. As IS infrastructure evolves, different level of capability maturity may be achieved.

In database system, large amount of data will emphasize on accuracy features. Timeliness problem is emphasized in network. Specifically, in our study most of the correlation between each aspect of information systems and information quality are of high significance (at significance level of 0.05). We suggest that information quality should be improved together with the information systems. In order to achieve this objective, a lot of information quality criteria should be watched upon, such as, accuracy, timeliness, accessibility, security, etc. Better performance may be achieved through resources improvement, process improvement, and design improvement. In different industry application and specific context, the requirements can vary. Moreover, at different information infrastructure maturity stage, the IQ feature demanded is also different.

On the other hand, different manufacturing operation will adopt different information systems according to their function and information needs. The information feature OM demanding is correlated with the production activity. For example, R&D demands accuracy of the information and also the ease of understanding and operation. Better information quality will facilitate the corresponding OM process. Compared with Table 5, Table 8 illustrates the information system that supports manufacturing operations at level of information quality. We found that quite a few consistencies exist at both system level and information quality level. Some information systems are expected to be important for almost all manufacturing operations, while some are expected not to be of great importance at all. Some information systems are quite important at IS level but not at IQ level and vise versa. IS infrastructure is deemed of high importance to internal operation at both IS level and IQ level. For example, DBMS contributes to production planning & scheduling by providing three important information quality features: accessibility, ease of understanding, and security. The property of database can be more fully utilized than in other operations, though it can also care for product life cycle management, inventory management, CRM, and Logistic and SCM.

Moreover, we find that the information system, which can facilitate corresponding function demanded by manufacturing system at system level, may not always provide good enough information quality. Literature examined how firms aligned their software processes, products, and strategies in Internet application development and reveal that the firms in the case study do use differing processes for Internet application development, and that many of the firms match their software process choices to product characteristics, customer volume, and business unit strategies (Slaughter et al. 2006). The feature of industry also affects the is adoption (Chris et al. 2005). Tensions exist at the interface between users who have unique manufacturing problems and demand flexible or customized information systems, and technology suppliers who have interests in promoting and supporting standardized solutions or methodologies. User firms need to recognize and address these tensions early when thinking about IS design (Swan et al. 1999).

Conclusions and Future Work

In conclusion, this study indicates several implications. For the adoption of CEPA, many applications fail due to the lack of knowledge about CEPA, unfavorable business environment, or wrong type of customer and market. Another obvious reason is that they are unable to move their plant to Hong Kong. In terms of adoption of IT, RFID and some advanced IS are only adopted in one or two specific domains or applications. It appears that the respondents cared more about the infrastructure of their companies than the external construction. “Productivity Improvement” is expected to be the most important issue in various manufacturing operations. “Production Planning and Scheduling” is the most satisfying area to the responding companies. Network is the most significant issue and the most satisfying area concerning the various information systems. “Accuracy” is the most important and of the highest satisfying level of information quality among the respondents.

From the discrepancy between expectation and satisfaction of information systems in the responding companies, it is found that the satisfaction level of “Productivity Improvements” cannot match the expectation. In addition, though the satisfaction level of “Enterprise Resource Planning” is not the lowest, it is far below the average. Even though its importance is not very high (maybe due to the fact that most of the companies in this survey are not large ones), it is still suggested to be enhanced because of its potential usage. The subjects in both “Productivity Improvements” and “Enterprise Resource Planning” should be highlighted or prioritized in response to the CEPA development. On the other hand, there is high consistency between expectation and satisfaction of information systems in the responding companies. Network, Internet, Web, DSS and DBMS are the top five issues in both expectation and satisfaction. The IS curriculum in MI disciplines should focus more on the IT infrastructure, such as the subjects related to networks, databases, and Internet.

This paper contributes to research in exploring the application of different IS in OM. We identifying the important correlation between IS and OM and suggest new research direction in terms of IS infrastructure and Advanced IS. We also proposed the practical suggestions to CEPA related authorities and general IS and OM managers. IT workers are suggested to pay attention to the corresponding information quality demanded by the operation process when developing IT artifacts.

There are also some limitations in the study. We can improve the research at least in three aspects. First, the questionnaire can be improved in terms of better definition of the concepts. A longitudinal study is expected to reflect the discrepancy between expectation and satisfaction. A bigger sample size is anticipated to get some insight into different industries, especially the large ones. The response rate is low and there are missing values in the small sample size. Second, further analysis can be applied to get more insights into the implications of the results. Data preprocessing was performed by a statistical consulting unit and we did not investigate multiple methods to deal with null data but treat them as missing data simply. We did not perform Exploratory Factor Analysis (EFA) on some data sets as it has restrictions on sample size. Reliability of the analysis was not discussed and principal component analysis (PCA) was not performed. As different respondents replied different questions and we would like to look into the reason why some of the questions are not answered by some respondents. The study on correlation between business size and respondent’s ratings are also interesting but failed in this study because of small sample size. Finally, well defined models is planed be applied to explore the relationships among information systems, information quality, and manufacturing operations. Therefore, the future directions are depicted as follows. First, there could be more correlation analysis of the data. For example, the relation of important factors and satisfied elements can be further investigated using statistical analysis. The correlation between the nature of the company, e.g. organizational size and industry property. Their IS characteristics can be analyzed with a larger data set. The further development of better information system should be foreseen. The Hong Kong Coalition of Service Industries (HKCSI) has recommended in its report “A Blueprint for the Hong Kong World City” that Hong Kong should be promoted as a telecommunication hub and a centre of e-commerce. Second, a follow up study with well-defined research models will be carried out to investigate the relationships among information systems, information quality, and manufacturing operations.

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